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The American STATISTICIAN

The news publication of the

AMERICAN STATISTICAL ASSOCIATION

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Volume 5, No. 1

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TECHNOLOGICAL APPLICATIONS of STATISTICS*

By L. H. C. TIPPETT, *British Cotton Industry Research Association.* Emphasizes and illustrates the practical points that come up in applying statistics to technology and the practical importance of the mathematical assumptions involved. The author is careful to pay particular attention to these basic assumptions and their implications for the technologist. This book serves as an introduction to the design of experiments in industrial research and helps the reader to appraise critically the contributions of statistics in industry. *1950. 189 pages. Illus. $3.50.*

CONTRIBUTIONS to MATHEMATICAL STATISTICS*

By RONALD A. FISHER, *Cambridge University.* This unusual volume is composed of 43 of the most important original papers on statistical research written by the outstanding statistician, R. A. Fisher. They were chosen, collected, and annotated by the author especially for this compilation. The reader is thus afforded the benefits of the author's own comments upon his work in the light of current information and research. Since the majority of these papers were available only in the largest libraries, the present collection will greatly facilitate the study and use of Dr. Fisher's contributions. *1950. 656 pages. $7.50.*

STATISTICAL DECISION FUNCTIONS*

By ABRAHAM WALD, *Columbia University.* Written under the sponsorship of the Office of Naval Research, this book presents the foundations of statistical decision functions—a comparatively recent development in general theory. *Statistical Decision Functions* makes possible multi-stage experimentation, and it includes the general multi-decision problem. The latter treats the important question of deciding with minimum risk which of several alternative decisions is best. This theory—a particularly significant one in business and industry—has never before been given a full book-length treatment. *1950. 179 pages. $5.00.*

STATISTICAL METHODOLOGY REVIEWS, 1941-1950

Edited by OSCAR KRISEN BUROS, *Rutgers University.* Statistical methods and concepts changed so rapidly during the 1940's that it was difficult to keep up with all of them, particularly since the advances were made by men working in so many different fields. This book contains capsule summaries and evaluations of every significant book published in the field in the last ten years and tells where to find the best, most significant information on each topic. A successor to the *Second Yearbook of Research and Statistical Methodology,* this book covers the field more thoroughly by confining the reviews to works on statistical methodology. *Ready in June. Approx. 100 pages. Prob. $7.00.*

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* A volume of the WILEY PUBLICATIONS IN STATISTICS, *Walter A. Shewhart, Editor.*

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The American STATISTICIAN

FEBRUARY, 1951, VOL. 5, NO. 1

The news publication of the
American Statistical Association

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REPORT OF THE COMMITTEE ON FELLOWS

In conformity with the new policy adopted last year, the Committee on Fellows has surveyed the foreign as well as the American membership. In the course of this survey it became necessary to consider whether honorary members should be elected as fellows. The Committee's conclusion is that they should not be, and the elections this year have been governed by this conclusion.

The Committee announces the election as Fellows of the following seven foreign members:

R. G. D. Allen, United Kingdom, who combines with rare balance a knowledge of mathematics and statistical theory, a critical judgment of economic data, and a capacity to analyze and interpret them for purposes of public policy.

Harold Cramer, Sweden, distinguished contributor to the theory of probability, mathematical statistics, and actuarial science.

Maurice G. Kendall, United Kingdom, for his outstanding contributions in many branches of mathematical statistics.

P. V. Sukhatme, India, for his contributions and pioneering work in the theory of sampling and design of experiment.

L. H. C. Tippett, United Kingdom, for his contributions to the theory and practice of sampling, the design of experiment, the statistical control of quality, and the improvement of industrial practices by the aid of statistical theory.

John Wishart, United Kingdom, for his contributions, varied and famous, in the analysis of variance and the design of experiment.

H. C. Wold, Sweden, for extensive contributions to time series analysis, econometrics, biological statistics and actuarial science.

The Committee announces the election as Fellows of the following eight American members:

Harold F. Dorn, for his notable contributions to the collection, classification, and interpretation of medical and demographic statistics.

A. Ross Eckler, for his leadership in the improvement of the methodology of census procedures and sample surveys.

Raymond J. Jessen, skillful designer and conductor of sampling investigation both in the United States and abroad.

A. D. H. Kaplan, versatile student of economics, for his discriminating use of statistical data in his economic researches.

Alexander M. Mood, distinguished contributor to statistical theory and its application to numerous wartime problems.

Oskar Morgenstern, distinguished contributor to national and international economic statistics and co-author of the Theory of Games and Economic Behavior.

Paul L. Olmstead, for his contributions in the field of the statistical control of quality, and the improvement of industrial practices by the aid of statistical theory.

Mortimer Spiegelman, distinguished for his work in demography and actuarial science, particularly in the field of self-renewing aggregates and the survival of family groups.

Morris Copeland, *Chairman*
W. Edwards Deming
Lester S. Kellogg
Frank W. Notestein
George W. Snedecor

NEWS

Eastern North American Region of The Biometric Society affiliates with ASA—scientific meetings—new publications—government projects—positions available

Biometric Section of the ASA Has New Charter Approved by the Council

The following Charter for the Biometrics Section of the American Statistical Association was approved unanimously by the Council at its meeting in December 1950:

"It is the function of the Biometrics Section of the American Statistical Association to represent within the Association the interests that, broadly considered, revolve about the application and interpretation of statistics and quantitative measurements in biology, medicine, health, plant and animal experiments in agriculture, and in related fields. The Section's major activities in discharging this function are (1) the arrangement of special sessions at meetings of the American Statistical Association, (2) the representation of the point of view of its members on American Statistical Association publications, including the Journal and The American Statistician, and on Biometrics, (3) the arrangement of special sessions with other organizations, such as those of pharmacologists, physiologists, or public health workers, and (4) representation of the Association on Committees organized in this field.

"The Section's interests overlap those of many other groups outside the American Statistical Association. The Statistics Section of the American Public Health Association and the American regions of the Biometric Society are the two with the largest overlap. From the point of view of the American Statistical Association, the important distinction is that the Biometrics Section represents the interests of biometricians organized within the American Statistical Association and has the primary responsibility for arranging sessions on biometrics at meetings of the American Statistical Association and its chapters, and representing it on committees, on publications and in other activities.

"The officers of the Section shall be nominated by a committee appointed by the incumbent Chairman of the Section Committee, elected by mail ballot and presented to the Board of Directors of the American Statistical Association for approval in accordance with the constitution."

Symposium on Application of Statistics

Three authoritative technical papers and discussions are included in a booklet "Symposium on Application of Statistics." These papers give emphasis to the importance of the application of statistics to qualify control in modern testing.

C. M. Wakeman, Testing Engineer, Los Angeles Harbor Department, and Chairman of the Symposium Committee, in his Introduction notes that the three authors were selected not only for their facility for introducing the subject of application of statistics to those not familiar with it but because they are so familiar with practical problems.

The papers are as follows: *The Economic Relationship Between Design and Acceptance Specifications*—E. L. Grant, Professor of Economics of Engineering, Stanford University; *Precision and Accuracy of Test Methods*—W. J. Youden and J. M. Cameron, National Bureau of Standards.

Copies of this 36-page pamphlet (STP 103) can be obtained from American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., at $1.00 each.

The Council of the ASA Approves Affiliation of ENAR

At its December 1950 meeting, the Council of the American Statistical Association voted unanimously to approve the application of the Eastern North American Region of the Biometric Society for affiliation to the American Statistical Association. The ENAR is the first society to affiliate to the American Statistical Association under the new Constitution which went into effect in 1948.

Membership of Statistical Commission of the UN

The Economic and Social Council at its eleventh session elected three additional members to the Statistical Commission bringing the total membership up to fifteen members in accordance with a recommendation of the Statistical Commission. In accordance with the rules of membership the term of office of the following four countries expired in 1950—France, Norway, Turkey and the United Kingdom, of these, France and the United Kingdom were re-elected. The membership of the Commission, together with the three new members is now as follows: Argentina, Canada, China, Czechoslovakia, Denmark, Egypt, France, India, Netherlands, Panama, Philippines, Ukrainian Soviet Socialist Republic, Union of Soviet Socialist Republics, United Kingdom, United States of America.

International Statistical Institute

The Twenty-seventh Session of ISI will be held in India in December 1951. The session will be followed by a Statistical Seminar where some of the world's outstanding statisticians will review recent developments in statistical theory and application in various fields.

Columbia University Trains Specialists in Scientific Calculation

Columbia University has announced the establishment of a concentrated program of study to train specialists in scientific calculation, critically needed in key phases of American mobilization.

Playing an essential role in the program, will be the scientists and machine facilities of the IBM Department of Pure Science, including the Watson Scientific Computing Laboratory located on the University campus and the IBM's giant Selective Sequence Electronic Calculator. Courses given by the IBM staff are integrated with those of the various departments of the University to provide an "unusually rich offering in the entire filed of applied mathematics."

The concentrated program offered in Columbia's Spring Session began February 5, under the Faculties of Pure Science and Engineering.

Instructors dealing with subjects most closely related to the machines include: R. R. Seeber, Jr., co-inventor of the Selective Sequence Calculator, who will give instruction in the preparation of problems for the machine, as well as in its use; Dr. L. H. Thomas, noted theoretical physicist, will discuss abstruse properties of differential equations which permit machine solution; and Dr. Eckert, who will discuss various types of calculating machines and their use in science. Enrollment in courses requiring laboratory facilities will be limited to maintain a high standard of achievement, with priority given to those actively engaged in defense problems.

Suggested Research Problems: Business-Economics

The Department of Commerce recently published the sixth edition of "Suggested Research Problems: Business-Economics," designed to help businessmen by stimulating research activity among college and university faculty members, to aid graduate students in selecting suitable thesis topics, and to provide directors and coordinators of business and economic research an index of current thinking on the part of business leaders and government officials concerning specific research needs.

With descriptions of 213 different research problems and problem areas, contributed by 181 different individuals and organizations, the bulletin touches all major fields of business and economics. Problem descriptions point out how findings may be utilized, indicate who would be interested in the results, and specify data sources available.

The volume was prepared by the Extension Service, Office of Small Business, National Production Authority, and can be purchased for 55 cents from Commerce Department field offices and from the United States Government Printing Office, Washington 25, D. C.

Fellowships Available

The Institute for Numerical Analysis of the National Bureau of Standards at the University of California, Los Angeles, has announced that properly qualified graduate students in pure and applied mathematics may be considered for summer studentships and thesis fellowships. Preliminary application must be made to the Director of Research of the Institute for Numerical Analysis before the first of March.

Other appointments at the Institute are made through regular Civil Service channels.

Applied Mathematics Opening in Johannesburg

The Chair of Applied Mathematics at the University of the Witwatersrand will be vacant after July 1951. Applicants for this department-head post should be qualified to teach applied mathematics, and have a background in theoretical or mathematical physics. Further information may be obtained from the Institute. Applications should be addressed to the Registrar, University of Witwatersrand, Milner Park, Johannesburg, Union of South Africa, with a duplicate to the Secretary, the Association of Universities of the British Commonwealth, 5 Gordon Square, London, W. C. 1, England.

Statistics Summer Session 1951

The Department of Statistics, Virginia Polytechnic Institute, will hold a special summer session August 1-19, 1951. It will be for graduate students, research workers, and technicians in government and industry. Special emphasis will be given to statistics in economics and engineering. Several visiting professors will participate in the lecturing. For details write the Department of Statistics, Virginia Polytechnic Institute, Blacksburg, Virginia.

Psychological Book Previews

PSYCHOLOGICAL BOOK PREVIEWS, edited by John W. French, is a new quarterly starting publication in January 1951. It is intended to help psychologists keep up to date on new books in Psychology and selected new books in Anthropology, Education, Neurology, Psychiatry, Sociology, and Statistics. Each issue will have 40-50 descriptive summaries of books written by the authors before their books appear. Each issue will also contain a bibliography of over 300 critical book reviews. The subscription price is $4.50 per year. Further information can be obtained from the Editor, 31 Markham Road, Princeton, New Jersey.

Comments Again Invited on the Constitution

The Constitution Committee is still charged with the development and consideration of proposed amendments to the Constitution and By-Laws of the Association. Members of the Committee are Theodore H. Brown, Merrill M. Flood, Millard Hastay and Clem C. Linnenberg, Jr.

All ASA members are reminded that they are invited to send their ideas on this matter to the Chairman of the Committee, Clem C. Linnenberg, Jr., U. S. Bureau of the Budget, Washington 25, D. C.

1951 Convention of the American Society For Quality Control

The ASQC will hold its fifth and largest annual convention in Cleveland May 23-24, 1951. Convention headquarters will be at the Hotel Cleveland. The theme of the convention is: *"Quality Control, Today's Foundation for Tomorrow's Reputation."* Several series of clinics are planned to present discussion on applications of quality control in diverse industries; however, one series will be devoted to the more technical aspects of the use of statistical methods. The training sessions constitute a condensed course in quality control for those desiring basic training under highly competent authorities on the subject.

Among sessions of interest to statisticians are:

Chemical Industries—Designed for those in the chemical or other industries interested in the frontiers of statistical application. For those interested in statistical devices and peculiar problems of pharmaceutical manufacture as presented by the men who do the work.

Mathematical Statistics—Designed for those with considerable background, and all others who are willing to accept some statistics on faith in order to enjoy those speakers.

General Interest—For those wishing a lucid, usable explanation of these valuable statistical tools. Recommended for Members-in-Training.

Training Sessions—Designed for those who wish to acquire an elementary working knowledge of Quality Control techniques which can be applied in their plants. Also recommended as a refresher for those who may have become somewhat rusty on basic principles, and for Members-in-Training, according to their needs.

Explanation of U. S. Foreign Trade and Shipping Statistics

A description and evaluation of U. S. statistics and foreign trade and shipping is now available in a 40-page pamphlet entitled "Explanation of Statistics." This pamphlet is a preprint of a section of the foreword to the 1946 volume of *Foreign Commerce and Navigation of the United States*, to be published shortly. The section describes how United States foreign trade and shipping statistics are compiled, the source documents used, difficulties and inaccuracies in the statistics, valuation definitions and practices, commodity classification and coverage problems, etc.

Although the description covers the statistics for 1946, in almost all cases the material presented is applicable to the foreign trade statistics currently produced. The "Explanation of Statistics" incorporates descriptions of current problems in the compilation of U. S. foreign trade and shipping statistics which appear in the monthly issues of *Foreign Trade Statistics Notes*.

Copies of the "Explanation of Statistics" are available without charge from the Foreign Trade Division, Bureau of the Census, Department of Commerce, Washington 25, D. C.

Los Angeles Chapter to Be Reactivated

All members of the Association interested in the reactivation of the Los Angeles Chapter should get in touch with John C. McKee, 1031 Cedar Street, Santa Monica, California.

New McGRAW-HILL Books

INTRODUCTION TO STATISTICAL ANALYSIS

By Wilfrid J. Dixon and Frank J. Massey, Jr.; University of Oregon. 370 pages, $4.50.

This unique text presents the basic concepts of statistics in a manner which will show the student the generality of the application of the statistical method. Both classical and modern techniques are presented with emphasis on the understanding and use of the technique.

MARKETING RESEARCH. How to Analyze Products, Markets and Methods of Distribution

By Ernest S. Bradford, Manhattan College. 379 pages, $5.00.

Discusses the principles and procedures employed in successful marketing research. Treats the basic elements such as how to analyze products and services, how to determine the character and volume of consumer demand, and what channels to use in order to get the product or service to market. Emphasis throughout is on securing and presenting marketing data.

HIGH SPEED COMPUTING DEVICES

By Engineering Research Associates. 451 pages, $6.50

Introduces the reader to the general character of computing machines and the arithmetic techniques employed in using them. Shows the basic circuits used to perform various functions in a computing machine, and the relationship between machine capabilities and the required mathematical tools. Intelligible, and up to date, this book will aid the reader in deciding which particular type of computing machine is adaptable to his particular problem.

STATISTICS FOR ECONOMICS AND BUSINESS

By Donald W. Paden, University of Illinois, and E. G. Lindquist, University of Iowa. Ready in April.

An exceptionally well-written book especially designed for the elementary course in statistics. A manual is available to accompany the text. Text and manual were prepared to be used together, since the problems in the latter are intended to guide the student in formulating for himself the principles to be learned.

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Security Controls Over the Publication of Statistics

The Bureau of the Budget has been requested by the President to maintain a surveillance of the publication of statistics by all Federal agencies, and to restrict publication of information in any instance where release of the information might endanger the national security. At the same time the Bureau was requested to insure that statistical information which is withheld from general publication because of security considerations may be released to authorized users under appropriate conditions.

The President's request for the institution of controls over the publication of statistics emphasized that in the national interest the restrictions imposed should be kept to a minimum, and that the statistical information needed by the Government and its citizens should be made available to the general public to the fullest extent compatible with national security.

In assigning responsibility for surveillance to the Bureau of the Budget, the President's request noted the need for uniformity and consistency in the control over statistical publication, the need for centralization of control in one agency, and the Bureau's existing responsibilities for the coordination, development and improvement of Federal statistical services. Within the Budget Bureau responsibility for carrying out this function is assigned to the Division of Statistical Standards, which is aided by an advisory committee representing the principal Federal agencies concerned with the national security.

Joseph W. Kappel, Division of Statistical Standards, Bureau of the Budget.

Integrated Reporting of Production and Employment in the Metalworking Industries

The Government has inaugurated two new basic statistical series on the metalworking industries to meet the needs of the emergency agencies for current measures as a basis for policy determination: a quarterly report of plant operations and a related employment report. The two collections have been planned together to provide an integrated picture of production and employment in these industries.

The plant report of operations has been initiated by the National Production Authority, and will use the collecting and tabulating facilities of the Bureau of the Census. It will collect quarterly data on shipments, inventories and use of critical metals from 8,000 metal manufacturing establishments. Data on employment patterns by shift will be collected from the same establishment by the Department of Labor in a supplement to the regular Bureau of Labor Statistics monthly report on employment, earnings and man-hours. The information on employment and man-hours collected by Labor will be made available to the National Production Authority for matching with the information on shipments and material-consumption collected by Census in the plant operations report.

Forms and instructions for both reports were developed with the assistance of a special panel of industry representatives designated by the Budget Bureau's business Advisory Council on Federal Reports.

Census Bureau Annual Surveys of Manufactures

The Bureau of the Census is completing work on an annual survey of manufactures covering 1949, and has started work on a survey covering 1950. These surveys are conducted under authority of the Census legislation enacted in June 1948, which shifted the Census of Manufactures from a biennial to a quinquennial basis and also authorized annual surveys on a mandatory basis. The latest Census of Manufactures was that made in 1948, covering calendar year 1947, and the first of the annual surveys was that covering 1949.

The annual surveys bring up to date the basic measures of manufacturing activity which are shown in more detail in the reports from the Census of Manufactures. These basic measures include total number of employees and production workers and their earnings, value added, value of shipments, expenditures for plant and equipment, and inventories. Data on shipments by broad product classes fill in important gaps in existing current reports on key manufactured products, and are not available from any other source. Reports from the 1949 annual survey should be released beginning in March 1951, and the collection of information for the 1950 survey was begun in January.

The surveys cover approximately 45,000 representative manufacturing establishments out of a total of about 240,000. All large plants, accounting for approximately two-thirds of the total manufacturing employment in the United States, as well as a sample of the much more numerous small plants are included. The final tables show as many industry and geographic totals as possible after taking into account the rules preventing disclosure of data for individual companies and sampling errors in the estimates.

Murray D. Dessel, Industry Division, Bureau of the Census, Washington 25, D. C.

National Scientific Register

The National Security Resources Board is sponsoring the compilation of a National Scientific Register to provide a systematic registration and classification of natural scientists and technologists in the United States. It is intended to use the Register for analyses of the supply of and requirements for scientists in various fields, and, in the event of large-scale national mobilization, as a referral and placement service for scientific personnel.

The basic resource data are being developed for NSRB by the Office of Education, Federal Security Agency. This office is collecting information from physicists, chemists, biologists, and a miscellaneous group including mathematicians, geologists, geophysicists and meteorologists. Questionnaires have already been mailed to a majority of scientists in these fields, and the research program is well under way. The national professional societies and councils are cooperating with the Government in this enterprise.

James C. O'Brien, Director of the National Scientific Register, Office of Education, Federal Security Agency.

Manpower Analyses of Selected Industries

The Bureau of Employment Security in the Department of Labor prepares each month detailed manpower analyses of selected industries. These analyses utilize supplementary information from other agencies but are based primarily on the Bureau's ES-211 schedule (Employer Information transcript). This schedule obtains information by establishment on employment levels (past, present and future), hiring specifications, shifts and hours of work, entry wage rates, in-plant utilization of women, current and anticipated occupational shortages, and other employment factors significant in the manpower picture.

As a result of the impact of the defense program, the Bureau of Employment Security has expanded the list of industries for which surveys are being made during the first quarter of 1951. The revised list was selected to meet the needs of defense production agencies as well as national, State and local employment offices for purposes of evaluating current labor market conditions and outlook and for developing necessary programs to deal with them. Information will be available by area of concentration as well as for the entire industry.

Brief summaries of the analyses will appear in *Labor Market and Employment Security*. Further information on the industries to be included may be obtained from the Bureau of Employment Security, Department of Labor, Washington 25, D. C.

Ruth Rosenwald, Division of Reports and Analysis, Bureau of Employment Security.

Statistical Literacy in the Social Sciences

by HELEN M. WALKER
Professor of Education
Teachers College, Columbia University

When the chairman of the program committee invited me to discuss Statistical Literacy at this meeting, I recognized at once not only that the subject was an important one but also that my qualifications as a speaker on the topic were unusual, perhaps more unusual than the chairman himself knew. In order that you may understand the full weight of authority which I bring to this subject, let me tell you something of my own struggle to become literate.

Shortly after I had begun to teach at Columbia the New York Board of Elections set up little wooden huts all over the city in which the civic-minded were expected to register their intention to vote in the coming elections. Residents of the apartment building where I lived, nearly all of whom came from faculty families, were assigned to a booth a block or so from the University and there I presented myself for registration. All went well until I was asked where I had previously voted. Upon hearing that this was the first time I had voted in New York, the chairman of the group in charge of registrations said with an air of finality that under the circumstances of course I could not register. After some insistent prodding, she grudgingly admitted that registration could be arranged if I was willing to take a literacy test, but she was sure I would not want to submit to such an extreme measure. I asked to see the statutes and in them I read that a new voter might prove his literacy either by taking a literacy test or by presenting "a certificate or diploma showing graduation from the 8th grade or a higher school." Abnormally conscious of my shiny new Ph.D. degree and my faculty status I smiled and promised to return with ample evidence. On the last day of the registration period I walked into the booth with a document which I fondly assumed would furnish cogent proof of my ability to read and write. The committee was aghast. They exclaimed that it was typewritten and surely I could not expect them to accept a typewritten statement. They were not personally acquainted with the college officer who had signed it. There was no reference to the 8th grade. It was not a diploma, no one would frame a thing like this and hang it on the wall. It began "this is to certify" and such is not the language of diplomas. Being a member of the University faculty was completely unrelated to literacy. Clearly I could not vote. Again we consulted the law and now they pointed to a phrase which said that in cases of doubtful literacy the board was empowered to use its discretion. This was a case of doubtful literacy and they were exercising their discretion to rule that I was not literate.

The public school where the literacy tests were given was 8 or 10 blocks away and I hurried lest its doors should close before I secured the coveted slip of paper. However upon arrival I found that a medical group was occupying the room in which the tests were customarily administered. It would be out of all reason either to give the test in another room or to interrupt the deliberations of the doctors. An hour or so later when I was admitted to examination, I was permitted to read a fourth grade story about some firemen putting out a fire, and to answer such searching questions as "How many firemen were there?" and "What caused the fire?" It will be a relief to you to know that I was able to pass the test and that I am now a *certified literate*. Since she had not been able to dissuade me from qualifying as a voter, the chairman was now slightly apologetic. "You see," she explained, "we have orders to be especially careful in districts like this where the per cent of illiteracy is so high."

Beyond a justifiable pride in having at least one certified literate among its members, what other concern has the American Statistical Association with literacy? Obviously the census definition of literacy is a matter of considerable importance to a great many statisticians, and the fact that different countries define literacy in different ways is creating problems for statisticians in the United Nations and in UNESCO. However if the census definition of literacy had been the chief concern of your program committee they would have looked elsewhere for a speaker, and I think they were aware of a different aspect of literacy which is a very appropriate concern of our Association.

In passing, however, let us see in what terms the various countries define literacy, for those definitions of verbal literacy may give us some useful clues as to the meaning of statistical literacy. Examination of the variety of interpretations of what constitutes technical literacy indicates that practically all such definitions are functional and that they involve two different variables – the component skills and the level of achievement in them. Some countries call a man literate if he can write regardless of whether he can read or not. Thus in England, Scotland, Wales, the Netherlands and Switzerland a man is illiterate if he signs the marriage register by mark. In Canada and Italy a man is illiterate if he cannot read regardless of whether he can write or not. In most countries literacy implies ability both to read and to write and in some it also implies ability to use simple figures. In the United States the current prevailing concept of literacy is a fifth grade standard of proficiency in the three R's. Age is a further complication in the definitions of literacy. The age above which a person unable to read or to write will be called illiterate ranges from 5 years to 15 years. The definition of an illiterate in India as a person 10 years of age or older who is unable to write a short letter and to read the reply is a

good illustration of the functional purpose which seems to underlie all these criteria.

If these definitions have a common denominator it is found in the fact that all of them are very simple functional statements and all relate to communication. In fact they define basic minimum ability to communicate such that a person with less than that minimum is at a crushing disadvantage in modern society. This personal disadvantage of the illiterate need not be discussed because it is obvious. Even the very word "illiterate" is a term of disrepute in this country. It is also obvious that if a nation has a high per cent of illiterates, it is at a great disadvantage in a complex modern society. In a primitive society what a man needs to know in order to earn a living and to be a useful member of the community can be taught orally. In a small and primitive community the facts and the ideas necessary to discharge one's responsibilities as a citizen can be disseminated by word of mouth. But in a large and complex modern state democracy depends upon the existence of an informed electorate and that in turn depends upon free and full communication between intelligent and responsible leaders and intelligent and responsible electorate. Democracy will not necessarily flourish in a literate community but it certainly cannot flourish in an illiterate community.

The liquidation of illiteracy throughout the world has often been described as one of the most urgent tasks of our generation, for to quote the Preparatory Commission for UNESCO,

> "When half the people of the world are denied the elementary freedom which consists in the ability to read and write there lacks something of the basic unity and basic justice which the United Nations are pledged together to further."

But the type of communication implied in the definitions of verbal literacy no longer suffices. The ideas which the modern citizen must understand are becoming more complicated and many of them cannot be grasped without some degree of statistical as well as verbal literacy. Nearly 50 years ago H. G. Wells wrote (in *Mankind in the Making*):

> "The time may not be very remote when it will be understood that for complete initiation as an efficient citizen of one of the new, great complex world wide states that are now developing, it is as necessary to be able to compute, to think in averages and in maxima and minima, as it is now necessary to be able to read and to write."

In the same way that complete verbal illiteracy is a stone around a man's neck making it impossible for him to pursue a skilled trade or to rise to a position of leadership among his fellows, even so does complete statistical illiteracy hamper a man in many vocations, interfere with the wise conduct of many of his personal affairs and drastically curtail his understanding of social issues.

If in a country there are too many persons who cannot read and write, the culture of that country does not flourish. If in a country there are too few notable and productive scholars, the culture of that country does not flourish. If the avenues of communication are not open between the scholars and the semi-literate, if the scholars write in one language and the people speak another, then the culture does not flourish. If a country wishes to raise the level of its cultural life, it must look to both ends and to the middle of the literacy continuum.

> To a very striking degree our culture has become a statistical culture. Yet the level of statistical literacy among the practitioners of the social sciences is appallingly low. To bridge the gap in the system of communication between statistician and social scientist substantial improvement is necessary in the social scientists' ability to use quantitative language.
>
> This will call for expansion in the undergraduate statistical curriculum; for early training of social scientists in mathematics; and for emphasis on the use of statistical methods in various social studies courses.
>
> Such a reorientation would require a particularly great effort to train competent teachers of statistics and to develop the art of exposition in the field of statistics.
>
> Is there anything that the ASA can do about these problems?

If in the Social Sciences there are too many practitioners who can not read statistical data with understanding, too many persons who misconstrue simple quantitative relationships, too many readers who turn a page hastily when they see that it contains tabular matter, too many persons who say smugly, "I am deeply interested in sociology (or psychology, or education, or economics) but statistically I am quite illiterate," if there are too many such practitioners who are statistically illiterate, the Social Sciences will not make satisfactory progress. On the other hand if the Social Sciences produce too few scholarly research workers who can combine a creative insight into the subject matter of their field with an expert use of statistical methods in the analysis of data, if the Social Sciences produce too few scholars who have a command of mathematics and can keep abreast of the newer developments in statistical theory, then discovery will be hampered and the growth of a body of tested knowledge will be slow and halting.

I have no data concerning the number of persons in the Social Science fields who might be considered statistically illiterate nor can I propose criteria by which they might be identified, nor do I think the search for such criteria would serve any very useful purpose. However I am personally acquainted with a fair number of Social Scientists who would unblushingly claim to be statistically dull if not statistically illiterate. Statisticians are supposed to abhor general impressions, but I intend here and now to hazard the statement of a general impression that not only in these fields but also among the ranks of college teachers of Education,

psychology, sociology, economics and government can be found many persons with very little comprehension of the statistical way of thinking. Again I have no data and prefer to seek none, but I have a strong and painful conviction that the number of scholars who can speak with authority in some area of Social Science and also speak with authority in the area of statistical theory is quite limited. It is beside the point to ask whether the situation is worse in the Social Sciences than in the natural and physical sciences and beside the point to make comparisons among the social sciences even if one could do so.

To a very striking degree our culture has become a statistical culture. Even the dullest person who may never have heard of an index number is affected in intimate fashion by the gyrations of those index numbers which describe the cost of living. Even on the most elementary level it is impossible to understand psychology, sociology, economics, finance, or the physical sciences without some general idea of the meaning of an average, of variation, of concomitance, of sampling, of how to interpret charts and tables. The deliberations of Congress and the state legislatures deal continually with matters in which it is impossible to reach a sound decision without weighing statistical evidence. Perhaps the clearest indication of the extent to which statistical ideas pervade modern life is the use made of such ideas by advertisers. Quoting statistics in favor of almost any product they wish to popularize, making liberal use of graphs, they tacitly assume that the American people are accustomed to thinking in statistical terms, or that if they do not understand they will at least consider a statistical argument incontrovertible.

Individuals who do not feel confident of their own ability to interpret a statistical statement usually resort to one or two extreme patterns, each unsatisfactory to the well-educated man. One of these extremes is the uncritical acceptance of any statement buttressed by numerical data, however fantastic. The other extreme is uncritical suspicion of *all* statistical reasoning. Between these two, the only alternatives would seem to be either dependence upon authority or some comprehension of statistical reasoning. One usually cannot depend upon having a satisfactory authority at hand, however, and the person who would make judicious decisions in regard to personal conduct and to public policy will frequently need to base those decisions on information essentially statistical in nature. The conclusion seems inescapable that some aspects of statistical thinking which were once assumed to belong in rather specialized technical courses must now be considered part of general cultural education.

To provide such general cultural education will require undergraduate courses in which applications are made to the whole range of human affairs and in which emphasis is on concepts, logic, sources of data, interpretation, avoidance of common fallacies.

Some of the principal ways in which the unwary can be deluded by careless or ignorant reading of statistical data have been vividly described by Darrell Hoff in his gay and caustic article on "How to Lie with Statistics" in the August issue of *Harpers*. Every statistician should read it.

Are there any practical steps which might be taken to improve the ability of the average American (mythical being!) to read simple statistical materials with understanding? Are there practical steps which might help the Social Scientist read more easily and rapidly the technical statistical materials which relate to his professional field? What can we learn about these problems from the experience of those who have led the fight against verbal illiteracy?

In the first place, the motivation to wage an all-out campaign against illiteracy always comes from the literate. Some highly literate person, a Jimmy Yen in China, a Torres Bodet in Mexico, a Frank Laubach in Africa, an Ambrose Caliver in the United States, becomes greatly concerned about illiteracy, believes it is possible to liquidate it, and induces in a large number of people the desire to learn to read and write and the expectation that they will be able to do so. The desire and the confidence are very important because learning to read and write is a formidable task. The fact that so many people master it is not because it is easy but because it is widely considered essential to a good life. In the United States the culture demands that people know how to read, and so children are held to the task in spite of its difficulty. So far as I can recall I have never met anyone who boasted that he could not read. I have known several adults who had invented an elaborate ritual to conceal the fact that they could not read printed instructions or sign a check, but they did not talk about these devices. By contrast, we all know people who say aggressively that they have no head for figures, never read a table, cannot understand a statistical chart, do not comprehend an average or an index number. Sometimes they even speak as though this were an idiosyncrasy reflecting some special credit upon themselves. In order that more people shall understand statistical data and statistical reasoning, more people must have a real desire to understand. So long as a man can maintain that he has inherited a mind allergic to figures he has an excuse to escape from the mental concentration and the patient labor without which no one understands a statistical relationship. To break down the superstition that some brilliant people are mentally incapable of quantitative thinking and to build up a popular desire to learn to read in the language of statistics will require devoted missionary zeal on the part of the statistical literates – namely yourselves.

A second lesson we can learn from the study of verbal literacy is that the new literate is eager to practice his skill and if he has no opportunity to do so, he loses it. During the first World War, James Yen was serving as YMCA worker with a battalion of Chinese laborers. Finding himself besieged to write and to read letters for the homesick illiterate coolies he inaugurated his famous experiment in teaching them to read. It was amazingly successful. He developed a basic list of about 1000 characters, later increased to 1320, representing words in the vernacular, which they mastered and in which they could communicate effectively. But they had become literate – for what? There was nothing for them to read. The vast literature of China was written in classical Mandarin and completely incomprehensible to them. Yen was obliged to start a

weekly newspaper for them and later, on his return to China, developed the special textbooks which served as vehicle for the Mass Education Movement. A similar series of textbooks using simple words but dealing with adult ideas has been developed for the new literate in our own country. One reason why the students of Social Studies do not make more rapid progress toward statistical literacy is that their statistical experiences are too largely limited to the courses in which they study statistics. They need to read more statistical material in their other courses. Perhaps the writers of texts in sociology and psychology and anthropology and social work are afraid to make liberal use of charts and tables for fear their books will not be read. We tell our students that they need to understand statistics in order to read the professional literature. Are we mistaken?

Another necessity in a program to make a community literate is teachers for the prospective literate, teachers who are able and willing to help the beginner, who believe he is worth helping. In our field this means that statistical concepts and statistical thinking ought to be introduced into the general education of all people as early as possible. If high school teachers understood statistical ideas it would be possible for them to present many statistical concepts in nontechnical form to their high school pupils and so in time an adult population would develop which could do more rational thinking in regard to quantitative data. In order for high school teachers to understand statistical ideas, it is necessary that *good* courses in statistics be offered in our teachers colleges, and that in turn calls for really adequate training of more persons on a still higher level.

A real difficulty in teaching verbal illiterates is that a great many adults assume that if they are exposed to thirty hours of teaching they should be guaranteed the ability to read. They are of course certain to be disillusioned and they will probably blame the teacher. Equally unrealistic is the student who assumes that taking a one semester course in statistics should make him able to conduct statistical studies. Learning to read and to write moderately well require years out of a child's life. Most of us who read and write statistics moderately well have contributed years to learning those arts and each succeeding year finds us less well satisfied with what we have learned because we see how much more remains to be mastered. There would be less discouragement on the part of the beginner if he did not expect such impossibly swift results. The computational skills of our field can be acquired in a fairly short time. Judgment, the ability to interpret, the clarification of concepts and the ability to plan a survey or an experiment are of slower growth. Consequently the one-semester introductory course in which students learn a variety of computations will inevitably turn out a large number of semi-literates.

Let us look at the other end of the scale and let us begin by recognizing that the best statistical education which could be obtained a decade or so ago is inadequate to the demands of today. That situation, I suppose, is the common lot of scientists, for the further one advances the further the horizon recedes. Like the Red Queen we must run madly in order to stay where we are. But the health of the social order is dependent on a continuing supply of tested knowledge. The research projects which can furnish such tested knowledge call for able persons who know the subject matter of their field, who know mathematics, who are inventive and original and possessed of a great thirst for discovery, and who have command of modern statistical theory and method. Such persons are urgently needed on the faculties of most of our major universities and on the research staffs of private and public organizations. There are several reasons why we have not been successful in enticing a large number of such persons into the field. The first reason is the obvious one that the qualifications are high and so the possessors are not numerous. Another reason is that many students do not discover their interest in statistical work until they are in graduate school, perhaps even preparing to do research for the doctorate in some applied field. Then they may bitterly regret that mathematics was not given a larger place in their undergraduate program, that they have discovered the field of statistics too late to master it. Another factor which keeps some able people from acquiring more thorough training in statistics is the rigidity of the usual college course of study in mathematics. The more mathematics the prospective social scientist can learn the better, but that does not mean that he should go through the usual sequence of courses. Often a young able graduate student appears who has mathematical ability but little mathematical training. He is enthusiastic about statistics as a career and decides he will make up his mathematical deficiencies. Then he is told he cannot take the mathematical theory of statistics until he has had calculus, he cannot take calculus until he has completed analytic geometry, he cannot take analytic geometry until he has had trigonometry. That means that three semesters will pass before he can even begin work in mathematical statistics, and probably he cannot prolong his graduate work to that extent.

Three remedies seem indicated. In the first place, as fast as competent teachers of statistics are available in larger numbers, courses in statistics should be introduced into the work of the undergraduate school. A definite movement of this sort is already under way. In the second place, social science majors should be urged to study mathematics while undergraduates or during the first year of graduate work and mathematics departments should be urged to provide a more appropriate offering. In passing, I should like to express the opinion that a carefully planned two year course of college mathematics could give the social science major such work in probability, limits, infinite series, integration (including gamma and beta functions), and matrix algebra as would enable him to read most of the books and articles which he will need to consult. When statistics courses are more widely available for undergraduates and when the mathematics departments provide a two year course covering some of the important topics which are now usually available only to students who invest more heavily in mathematics, then we may expect to have many more graduate students who can read statistical materials rapidly and with critical understanding. There will then be more social science students who can understand the value

of really thorough training in statistics while they are still young enough to make such training profitable and thus the company of productive scholars and teachers will be assured. In the third place, you and I must have the courage to insist that the next generation of college teachers of statistics shall be more literate than we. And here the word "literate" is exactly what I mean, they must have the training which will enable them to read more widely and more rapidly in all the scientific journals of our field.

The field of verbal literacy furnishes another parallel for us to consider. Adult education is actively concerned with the mature worker who needs periodic retraining. There must be many persons all across the country who had what was considered an excellent education in statistics a decade or so ago but who now experience great difficulty in reading the literature. The language has changed and they no longer understand it. In this field the rate at which knowledge becomes obsolescent is a professional hazard. In perhaps a dozen centers there are universities near enough for them to enroll in evening and Saturday courses. A few organizations have enough statistical workers on their staff to set up special courses for them, but for the most part these workers would have to take a leave from their positions and go to another city in order to join a class of any sort. A few persons with more-than-average initiative and with more-than-average mathematical ability will achieve self-education. This group of persons who need refresher courses includes workers in state and municipal offices, in welfare agencies, in business and industry and finance. It also includes college teachers, and for them I think some special plan should be worked out. It would be particularly helpful if the college teacher of statistics could every now and then have a short period of service doing statistical work in some scientific or governmental or commercial agency. It would help him to remain practical and resourceful. Also it would be helpful if some one of the larger universities would set up a summer course for teachers of statistics. This should be quite different from the usual course for persons studying the subject de novo. There should be lectures to bring teachers up to date on the more important general ideas and there might well be a sort of workshop where the teachers themselves would exchange ideas about teaching devices and organization of material.

We have been talking about the improvement of literacy as if it were primarily a matter of increasing reading ability on all levels, but there is another side to this shield. If a man does not understand what I write, dare I assume that all the trouble is with him, that the only way to improve communication with him is to teach him to become a better reader?

Everyone who is here today, including myself, is a reader of statistical books, papers, and reports, and everyone of us aspires to become a more competent reader. But also almost everyone here is a writer or a potential writer of statistical books, papers and reports, and I doubt that we have given much thought to the possibilities of improving our competence in that area. Let us now take a look at the principal reasons why communication fails between writer and reader, between speaker and listener, or between teacher and pupil. I shall use the word reader to mean the person trying to receive the communication, whether he is reading written material or listening to an oral presentation, and shall use the word writer to mean the person whose ideas are to be communicated, whether he sets them down in writing or delivers them in speech.

If a reader is too dull mentally to comprehend the ideas he wants to read, there is little that anyone can do to promote communication with him; but dull people seldom make persistent and prolonged effort to comprehend what is truly beyond their capacity. The dull usually remove themselves from our audience and turn to more pleasant pursuits. The readers' stupidity is therefore not to be claimed as an adequate excuse if many people find a particular piece of writing difficult to read.

No matter how alert a reader is mentally, he cannot expect to be able to reach technical writing for which he lacks a necessary background of knowledge. The principal remedy called for in this situation is for the reader to undertake such prior study as is essential. However the reader who is on his own who is not a member of a class with a teacher to whom he can turn for a suggestion as to what he should study, cannot pull himself out of this difficulty. If the writer cares greatly about being understood, he may be able to offer an occasional clue to the reader as to where he can find further elucidation. My own first contact with statistical method or theory came from reading a research monograph which fell into my hands more or less accidentally when I was a beginning high school teacher. The footnotes bristled with small r's and small sigmas, each having a long train of subscripts fore and aft, but there was no suggestion as to how one might find out what these symbols represented or how their numerical values were computed. The subject matter of the monograph fascinated me and I would gladly have read half a dozen books to find the meaning of these footnotes, but no one could tell me where to find such books. I asked everyone I knew. One man said he had been at the University of Chicago the previous summer and he thought there was something about r in some of his notes, but he never found the notes. So I gave up my high school teaching and went off to graduate school largely because I could not endure my reading disability.

Sometimes a reader's disability comes from carrying over into statistical reading the habits of very rapid skimming which he has found to be an asset in reading purely verbal material. Those of us who teach first courses in statistics may be able to suggest to our students that they learn how and when to change gears.

The three causes of reading difficulty which I have just mentioned – dullness, lack of preparation, and poor reading or poor study habits on the part of the reader – are matters about which the statistical writer need take little responsibility. I can think of several other reasons why communication is unsuccessful between writer and reader and none of these reasons reflects credit upon the writer. These sources of reading difficulty seem to me to come from a series of road blocks which the writer has thrown up in the reader's path and the reason he has dug these pitfalls, inserted

these traps, failed to remove these fallen trees, and neglected to clear away the ice and snow, is that fundamentally he cares more about himself than about the reader's progress.

For illustrations of how this species of self-absorption interferes with the wrtier's ability to communicate his ideas to the reader, let us think about a student writing a thesis which is his first important piece of professional writing. You say to him "This passage is not clear" and instead of trying to revise it he replies that if you will reread one passage in a preceding chapter where he describes the observations he made and will read another passage in a subsequent chapter where he states certain limitations of his data, and if you will compare the second column of Table 7 with the third column of Table 12 and will recall a footnote occurring two pages earlier, he is confident that you will understand the passage in question. The student has shown disrespect to his readers by implying that they can afford the time and energy to dig out an obscure passage while he cannot afford the effort to clarify it. He has also shown disrespect for his own data and conclusions. If he believes his study to be genuinely important he should feel a strong desire to have it understood so that utter clarity of presentation will be one of his goals.

Another way to explain the student's lack of clarity is to say that he had not visualized his audience. If his readers had been actively present in his mind he would have put a little more attention on ways in which an intelligent reader might possibly misinterpret his meaning. The self-centered writer does not put much thought on how to make his material more useful to his readers because he is absorbed with the question of how they will regard him. The student writing a doctoral thesis is naturally often preoccupied with the impression he is going to make on his thesis committee and he makes unconscious attempts to impress them with his profundity or his erudition. Such attempts almost always interfere with the communication of ideas, but it seems to me that the interference is particularly serious when the treatment is statistical in nature. When a writer becomes so interested in the ideas he has to communicate and so eager to have those ideas fully and clearly understood by his readers that he is aware of himself only as a responsible link between his ideas and his readers, then he dares to write with simplicity and humility, not caring to be admired but only caring to be understood. If that is a platitude, at least it is a pertinent platitude.

As you read papers in the statistical periodicals or read books on statistical methods or theory, you probably note that an author may write on one occasion with crystalline clarity and on another with what seems almost deliberate obscurity and you speculate as to the reason why. Is it due to haste? Certainly a deadline to be met and the conflict of many competing tasks can play havoc with the best intentions. May there sometimes be an unconscious willingness to remain obscure in order to be thought profound? If a piece of writing is so clear that the ideas seem obvious or the facts seem unimportant the writer may not be hailed as a great authority. If an author should begin to suspect that his discoveries are less momentous than he had hoped and if he is tempted to take refuge in a mild form of obscurantism which will leave his readers searching for deep meaning in his material and blaming their own stupidity when they fail to find it, then unfortunately statistics can be made to serve his purpose.

While hasty writing and unconscious willingness to be unclear may account for some of the obscurity about which the readers of statistical materials complain, neither one is, I think, the most common source of difficulty. More often the writer honestly misjudges what his readers already know about the subject. Many of us who are writers or teachers suffer from the peculiar affliction of assuming that everyone else knows exactly the same things we know. This malady causes us to explain in great detail a simple concept which we have recently acquired and to gloss over a really difficult concept which has long been familiar to us. It causes us to omit important steps in describing how our data were gathered and to draw up tables which are incomprehensible unless one already knows what they mean. In the writing of the mathematical statisticians this seems to me to be the chief barrier between reader and writer. The field of mathematical statistics now has become so extensive that it is possible for a man to be an expert authority in one phase and a relative novice in another phase. When such a person sits down to describe for the *Annals* one of his most recent discoveries he is likely to have in his mind not the whole class of mathematical statisticians but the small subclass of other mathematical statisticians who have been working on closely related problems.

In any field the professional inevitably learns many things which the non-professional does not know. He can speak and write with less effort and with greater precision if he employs the professional shorthand. When he is writing solely for the benefit of other professionals, use of the special vocabulary and special shorthand enhances communication and should never be decried. But let us be on guard against using our professional language in the way that certain ancient priesthoods used a priestly language partly to keep the laity from understanding them and partly to demonstrate that the user was one of the elect, that he had entered the royal arcanum.

The possibility of cure for the habit of misjudging what one's readers know about a topic is conditional upon an earnest desire to be cured. Granted such a desire, there are two obvious remedies. (1) If a paper can be laid aside until it is "cold," when the author is no longer so deeply immersed in it, he will himself recognize that certain passages are needlessly obscure. He may even say, on rereading, "Now what could I have meant by that?" (2) Still more effective is it to have the paper read by one or two persons less closely related to the material who will put some attention on ways in which it could be misunderstood. Most large concerns do this as a routine before releasing a report to the public. Writers of expository papers on statistical theory and method usually have students who would gladly serve as guinea pigs.

Leta Hollingworth, who was perhaps the world's greatest authority on the exceptional child, that is the extremely brilliant or the subnormal child, used to say that it was practically impossible for the genius to communicate with the moron. The person with IQ

of 190 might be able to teach one with IQ 160; IQ 160 could teach IQ 130; IQ 130 could teach IQ 100; and IQ 100 could perhaps teach IQ 70, but only a rare person of IQ 190 could teach even one of IQ 130 because the former could not understand what it was that was unclear to the latter.

Perhaps levels of statistical training produce an analogous situation. It may very well be that a person who has spent years in gathering and analysing data, in planning large scale studies and in managing a staff of statistical research workers has so lost touch with his own early difficulties that he is not the best person to make explanations to a novice. It may very well be that a person who has spent years studying the mathematical theory of statistics is a poor teacher of an introductory class because he can see no reason to explain that which is perfectly clear to him. Such lack of communication between the expert and the novice is not inevitable. In every field there are a few great scholars who can speak simply and directly to the uninitiated, but they are rare. I believe that the healthy development of a technical field depends in part upon the existence of a group of creative and highly literate scholars who are actively extending the boundaries of knowledge in that field and that it depends in part upon the existence of a large number of persons who have some general comprehension of the field and from whose ranks future scholars can be recruited, and I also believe the welfare of such a field depends in very large part upon the existence of a group of competent middle men who can interpret the scholars to the laity. Our field, I think, may be very proud of its scholars, less complacent over the literacy of the general public, and genuinely concerned as to the number of good interpreters.

One group of persons who could profitably undertake such tasks of interpretation are advanced students enrolled in university departments of statistics. It would in my judgment be valuable to encourage them to write for a master's thesis an expository paper drawing together all the most important ideas on some one topic, and illustrating it with applications in several fields. Publication of the best of such papers might be undertaken by the ASA in a monograph series. If that is not feasible a really good paper describing new and unfamiliar methods in simple language would be readily acceptable by some periodical. Thus new and improved techniques would be more rapidly diffused and so the level of statistical work would rise. For the students the writing of such a paper would require wide reading and thorough acquaintance with the literature and so would give them valuable training both in statistical theory and in its applications. It would tend to call their attention to unsolved problems which might be appropriate for doctoral study and so the attempt at exposition of discoveries made by others might actually be a stimulus to discoveries of their own. Furthermore, they should in such an undertaking learn high standards of exposition which would make them better writers or better teachers all the rest of their lives.

May I close with the words of Francis Galton, "Statistics are the only tools by which an opening can be cut through the formidable thicket of difficulties that bars the path of those who pursue the Science of Man."

I have tried to suggest some of the problems to be faced in keeping that path from degenerating into a maze. These problems are now before you. Is there anything that the ASA can do about them?

NEWS

Census of Private U. S. Direct Investments Abroad

The Balance of Payments Division, Office of Business Economics, has begun work on a new census of private United States direct investments abroad. The new census will provide the first complete survey of direct investments for the postwar period, and thus will serve as a valuable benchmark for the quarterly and annual estimates of capital movements and income on direct investments prepared by the Balance of Payments Division.

This project is financed with Point Four funds allocated to the Department of Commerce. It is being supervised by Joseph A. Zettler, formerly on the staff of the Bureau of the Census.

Industrial Research

The Department of Industrial Engineering, Columbia University, will conduct its Second Annual Conference on Industrial Research during the week of June 11-15, 1951.

Details and program will be announced shortly by Professor David Bendel Hertz, Director of the conference.

The 1950 conference was chiefly concerned with the administration of costs and budgeting. In 1951, the emphasis will be on the selection, training, and administration of research personnel.

Columbia to Hold Conference on Industrial Personnel

A "Conference on Industrial Personnel" at Columbia University will be held March 19 to 23, 1951.

Under the theme of "The Frontiers of Personnel Administration," certain new concepts of personnel administration will be presented in lectures and round-table clinic discussions between authorities on various phases of personnel administration and representatives of approximately fifty leading industrial and business concerns. Many of these new concepts and ideas have been tested experimentally in certain industrial organizations but have not as yet been widely publicized or their advantages realized on a broad front.

The eight general topics to be covered at the Conference are: Communications; Design for Communications; The Theory of Joint Participation; The Practice of Joint Participation; Occupational Guidance in Industry; Budgeting of Employment; and Flexibility and Tolerances in Personnel Systems.

Information on the Conference and registration procedure may be obtained by writing David N. Edwards, Columbia University, Department of Industrial Engineering, New York, N. Y.

Statistics Show

The Second Annual Statistics Show, co-sponsored by City College and the New York Chapter of the American Statistical Association, was held in New York City on February 15th. The purpose of the show is to keep the business community up-dated on the latest developments in the field of statistics and research.

Included among this year's exhibitors were: American Iron and Steel Institute, American Petroleum Institute, Bureau of Advertising, Friden Calculating Machine Com-

pany, Magazine Advertising Bureau, Marchant Calculating Machine Company, Monroe Calculating Machine Company, National Bureau of Economic Research, National Industrial Conference Board, United Nations, U. S. Bureau of the Census, book publishers and other organizations.

The Casualty Actuarial Profession

A booklet, "The Casualty Actuarial Profession, a Business Opportunity, has been prepared by the Casualty Actuarial Society "to acquaint young men and women of high caliber, who have sound judgment and a taste for mathematics, with the opportunities available in the actuarial profession. Additional information about this field can be obtained from Richard Fondiller, Secretary-treasurer, Casualty Actuarial Society, 60 John Street, New York 7, New York. A pamphlet, "Recommendations for Study," past examinations, and the C.A.S. Yearbook are also offered to applicants.

Symposium on Bulk Sampling

The 1951 annual meeting of the American Society for Testing Materials, which will be held in Atlantic City in June, will include a Symposium on Bulk Sampling. C. A. Bicking of the Hercules Powder Co. and W. E. Deming of the Bureau of the Budget are Symposium chairmen. Papers will be given by:

Louis Tanner, U. S. Customs Laboratory; C. W. Dunnett, Department of National Health and Welfare; A A. Orning, Carnegie Institute of Technology; Joseph Manuele, Westinghouse Electric Corporation, and Carl Noble, Kimberly-Clark Corporation.

Correction

The National Conference Board has informed the American Statistician that the free distribution of "Road Maps of Industry" is restricted to high school teachers, staff members of teachers colleges and to administrators at these levels.

NEWS about MEMBERS

C **Phyllis Carter** who has been working in the statistical information services for the Inter-American Statistical Institute for the past seven years, has been appointed Chief of the Census Library Project of the Library of Congress.

Jack Chassan has left the U. S. Public Health Service and is working with the Department of Medicine and Surgery of the Medical Statistical Division of the Veterans Administration in Washington, D. C.

Gladys N. Conley formerly of the John Randolph and Dora Haynes Foundation has accepted a position with the Statistical Division of the International Labor Office in Geneva.

F **Will Feller** of Cornell University has been appointed Eugene Higgins Professor of Mathematics at Princeton University.

G **Walter S. Gifford** of the American Telephone and Telegraph Company has been appointed American Ambassador to the Court of St. James.

Richard H. Goebel, Jr., formerly Statistician of the Cigar Manufacturers Association, has recently been appointed Statistician in the Foreign Production Division, Gulf Oil Corporation, New York City.

H **Robert J. Hader** has left Los Alamos to work with the Department of Experimental Statistics at North Carolina State College.

Floyd J. Hosking has been elected Executive Vice-President of the Corn Industries Research Foundation of New York and Washington.

L **Eugene Lukacs** has joined the staff of the Statistical Engineering Laboratory of the National Bureau of Standards. At the Bureau, he will be engaged in research in mathematical statistics, particularly autoregressive series and stochastic processes.

M **S. Sterling McMillan,** associate professor of economics at Western Reserve University, has been granted a leave of absence for the second semester to accept an appointment with the National Production Authority in Washington as director of the regulations and orders staff, Bureau of Industry Operations.

Sigeiti Moriguti, Assistant Professor of Applied Mathematics at the University of Tokyo, is spending the academic year 1950-1951 in research and study of mathematical statistics at the University of North Carolina under the sponsorship of the United States Army. He is the author of numerous research articles and a book on the theory of statistics.

P **Robert L. Patton** is now serving as Chaplain in the U. S. Naval Reserve. He is with the 1st Engineers Brigade of the First Marine Division in the Pacific.

William H. Peckham has joined the American Brass Company in Waterbury, Connecticut, as an Industrial Management Statistician.

F. Gardner Perry has accepted a position with Utopia College in Eureka, Kansas.

Theodore H. Preiser has opened an office in New York as a wool textile production cost consultant. From 1933-1948 he was in the Middle East, returning to New York two years ago.

R **Edith H. Rafton,** for many years Supervising Medical Insurance Statistics Assistant in the Statistical Bureau of the Metropolitan Life Insurance Company and recently of the Health Center for New York City hotel union employees, is now Statistical Associate at the Institute of Life Insurance. She will be responsible for the medical statistics and will supervise some of the special surveys conducted at the Institute.

Sydney C. Reagan has been appointed Chief of the Economic Analysis Section of the Fats and Oils Branch, Production and Marketing Administration of the Department of Agriculture in Washington, D. C.

S **G. R. Seth** has returned to India to accept the position of Professor of Statistics and Deputy Statistical Advisor to the Indian Council of Agricultural Research, New Delhi.

Herbert S. Sickel has returned to his work with the National Institute for Personnel Research in Johannesburg, South Africa.

W **Faith M. Williams,** Chief of the Division of Foreign Labor Conditions of the Bureau of Labor Statistics, has been elected to membership in the Societe de Statistique de Paris.

Y **William J. Youden** of the National Bureau of Standards has recently been elected to Fellowship in the New York Academy of Sciences. Internationally known as a mathematician and chemist, he is one of 106 distinguished scientists chosen for this honor from among the 5,300 current members of the Academy, the fourth oldest scientific organization in the country.

THE DEVELOPMENT OF STATISTICAL QUALITY CONTROL IN THE UNITED STATES

by S. B. LITTAUER
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This is the second of two articles

4. Statistical Quality Control and Progress—1945 On.

The close of hostilities in 1945 might be a good point in time at which to give pause and consider the promise held forth by developments in statistical quality control. It is not possible to give account of all the individual contributions made since then but it may be possible to indicate the directions in which the fundamental ideas of Shewhart are being implemented in carrying on the day to day work of our industrial society and it may be possible to suggest the way in which these ideas have stimulated contributions to its progress. It must be understood, therefore, that the discussion here can be aimed at best towards indicating in general how developments in quality control facilitate attaining the objectives of our daily lives, and that reference to one particular item intends no slight to other items which through oversight or ignorance have not been mentioned.

Much of what might be given here was already given some years ago by S. S. Wilks.[14] After reviewing accomplishments of the war years he stressed the need not only for training engineers in basic statistics and quality control but for such training in statistics and scientific method as might fit engineers and statisticians for examining the more complicated problems arising in such important work, for example as Consumer Research and Industrial Operations Research. Shewhart has long stressed the need for studying consumer needs and wants. Granting that these terms need operational defining, our intuitive notions of them are real enough to suggest the broad scope of scientific techniques which research in human needs requires, for certainly the basic motivations of industrial applications of quality control lie in the pressures of consumer interest, raising not only such questions as the writing of realistic specifications but also the problems of what products to make, what materials to use, how best to effect inventory, sales or budgetary control and the like. Recognition of some of these problems was evidenced in 1945 when the National Research Council and the Social Science Research Council set up a joint committee to study the measurement of consumer opinions, attitudes and wants. Again in 1946 the University of Pennsylvania sponsored a conference on experimental method in the Measurement of Consumer Interest,[15] which attracted considerable interest from workers in a wide variety of fields not ordinarily thought of as having common ground. The extent to which this apparent interest is being practically implemented cannot be readily gauged except to point to such cases as, for example, the work being done in the Bell Telephone Laboratories where psychologists have joined the technical staff in the study of telephone equipment design from the viewpoint of the consumer.

Another aspect of industrial operations to which the methodology of statistical quality control has recently come to be applied is concerned with the rate of production. Common current practice still employs elementary techniques of time measurement, and the subjective distortion and discarding of observations in violation of accepted tenets of scientific method. Although in 1935 Tippett[16] published a fundamentally important paper demonstrating the practical usefulness of statistical methodology in studying industrial productivity, to date the number of statistical papers in this field is negligible. The first published impetus for the application of Shewhart's ideas and the techniques of statistical inference to "time study" was given by William Gomberg in his book, "A Trade Union Analysis of Time Study" (Science Research Associates, Chicago, 1948). After analyzing critically the unsound practices in use, he emphasized the need for establishing statistical control of the rates of performing manufacturing operations and for studying the statistical independence of the successive elements which supposedly constitute such operations. Fruitful research in this direction has been performed by Adam Abruzzi[17] in the study of worker paced operations in the ladies garment industry. [Further work on the statistical control of manufacturing operations is being conducted in the Industrial Engineering Department of Columbia University.[18]] The field of industrial productivity should prove to be fertile ground for applications of statistical control.

If we consider in addition to the recent developments mentioned above the increased applications of statistical method occurring in research, design and development, as well as the potential applications to the suggested management aspects of manufacture, there emerges the broad basic problem of industry, namely, maximizing the standard of living. This general problem cannot readily be formulated in specific terms and perhaps can only be incompletely broken down into operationally definite components. The overall problem confronting industrial management from the inception of a product to its completed manufacture and distribution is the problem of Industrial Operations Research, quite analogous to the problems of overall military strategy for which the expression Operations Research was coined. They are problems in the application of scientific method in the most general sense, whose solution have been

made somewhat tractable by the availability of the methods of statistical control and statistical inference, where techniques of the various substantive sciences alone are not adequate. In problems of operations research, whether civilian or military, statistical quality control in its most general sense as the means for analysis of causes is indispensable. While the development of industrial operations research is yet but one of the promises emanating from the development of statistical quality control, present indications are that the operations research groups of various branches of defense are expanding their activities and that their current problems are in many ways analogous to those confronting industry.

To evaluate the extent to which the practice of quality control has been intensified and extended on a nationwide scale would require a survey beyond the means of any individual. Undoubtedly most readers have seen evidence of letdown following the war and have encountered cases of lip service to the merits of quality control where genuine application was wanting. This is not peculiar to quality control for in all scientific disciplines practice varies both in soundness and in extent. Nevertheless, if the experience with industry of many persons consulted is typical, and if such signs as the growth of the American Society of Quality Control, the increase in number and technical merit of articles published in a wide range of trade and technical journals, the increase in job opportunities and the increase in student interest can be taken at face value, then the practice of statistical quality control is growing strongly. Furthermore, in all the branches of the armed services the quality control sections are active in promoting good practice. The extent and degree of refinement of the present status of quality control practice in industrial operations is not the pertinent fact – what is important is the definite indication that the practice of statistical control and related techniques is an accepted part of efficient and economic industrial operation, and that this practice is growing apace.

Again we may consider the signs in the literature and in the activities of the professional societies. Enumeration and lengthy discussion of the literature is not possible here, nor could it be considered appropriate to give even a cursory evaluation of the publications which are appearing. What is important is that currently many articles in such periodicals as the *Annals of Mathematical Statistics* and in the *Journal of the American Statistical Association* are directed towards and concerned with industrial and other quality control applications. In the interesting series of articles, Practical Applications of New Theory: A Review by Frederick Mosteller and John Tukey in *Industrial Quality Control* (Vol. VI, No. 2-5, 1949) emphasis is given to recent statistical theory, inspired by both formal and practical considerations, which promises fruitful use in the practice of statistical quality control. In general the tenor of articles in *Industrial Quality Control* is shifting towards topics of greater sophistication than was common in the early issues of the journal. The practice of statistical quality control has not only continued to stimulate research in formal and theortical statistics but has become a sufficiently regular part of the various engineering and scientific disciplines, so that articles on applications in a large variety of journals in substantive fields are rather expected than exceptions.

A particular phase of the literature which represents important progress in quality control deals with acceptance sampling, or sampling inspection, which has come to be looked upon as a self contained discipline, especially since its efficient practice still presents some neat problems in the guarantee that the formal principles involved assure attainment of specified empirical objectives. In the considerable body of statistical theory that has developed around acceptance sampling, the newer work deals largely with multiple and sequential sampling, variables inspection and A.O.Q.L. sampling for continuous production. While a number of new tables have been produced under the Office of Naval Research and while some tables on sequential sampling for fraction defective based on inspection by variables have been considered recently for publication, the latest work to be published is *Sampling Inspection*[19] which at the time of its publication in 1948 was the most comprehensive treatment of inspection by attributes. The more recently published papers and discussion delivered at an all day session of the 105th Annual Meeting of the American Statistical Association (Cleveland, Ohio, January 27, 1946)[20] offers an extremely interesting review of both the theoretical and empirical developments in acceptance sampling. Among the interesting problems raised at this symposium is the relative merit of the sample range in place of the sample standard deviation in the practical aspects of variable inspection. Recent publications in England on the noncentral G distribution[21] and work in progress in this country on tables for variables inspection for fraction defective utilizing the sample range instead of the sample standard deviation represent advances in this direction. Of a more general nature, however, and perhaps of equal importance with any of the ideas

[14] "Research and Training in Industrial Statistics for the Future," *Industrial Quality Control*, 1947, presented at a joint dinner of Metropolitan New York Section of the American Society for Quality Control and the Acceptance Sampling Conference, Newark College of Engineering.

[15] *Measurement of Consumer Interest*, edited by C. West Churchman, Russel L. Ackoff, Murray Wax, University of Pennsylvania Press, Philadelphia, 1947.

[16] L. H. C. Tippett, "A Snap-Reading Method of Making Time-Studies of Machines and Operatives in Factory Surveys," *Journal of the Textile Institute*, February, 1935.

[17] "Experimental Procedures and Criteria for Estimating and Evaluating Industrial Productivity," Ph.D. dissertation, Department of Industrial Engineering, June, 1950.

[18] This work is being carried on by the writer with the assistance of Stanley Millberg, under a grant from the Wertheim Foundation, Harvard University.]

[19] By the Statistical Research Group, Columbia University. Edited by H. A. Freeman, Milton Friedman, Frederick Mosteller and W. Allen Wallis, McGraw-Hill, N. Y.

[20] *Acceptance Sampling*, the American Statistical Association, Washington, D. C., 1950 This work offers excellent coverage of the literature up to 1947.

[21] See Daly, Joseph F., "On the Use of the Sample Range in an Analogue of Students *t*-Test," *Annals of Mathematical Statistics*, March, 1946.

presented in this volume was the recognition of the integration of acceptance sampling with statistical control as a fundamental aspect of scientific method. It might be well to refer the reader to John W. Tukey's elegant closing remarks as Chairman, in which he indicated the formal, theoretical and operational nature of the work which contributed to the present status of acceptance sampling and unfolded the problems ahead.

A development which has not yet received the full attention its promise merits is to be found in continuous A.O.Q.L. sampling. Following the original work of Dodge[22] for processes in statistical control Wald and Wolfowitz[23] presented a system by which a given level of fraction defective is guaranteed (in the limit) after inspection, independent of the state of control. In addition, if the process is in control the total inspection is minimized. If one focuses attention on continuous production, process control and acceptance sampling become parallel and complementary to one another. For it is a fact that a specified limiting level of fraction defective of a product is an economic or social objective and statistical control is a means for attaining this objective. However diligent one's effort at process control may be, one may never attain long periods of stability or one may attain stability at a level of fraction defective greater than that desired. Hence in any realistic practice of statistical quality control in mass manufacture some economic form of sampling inspection may be required in order to eliminate enough defectives so that product may come out at a level of fraction defective consistently not greater than that specified. The requirement of consistency raises some delicate questions of "local stability" in the sense used by Wald and Wolfowitz. It may not be an idle conjecture, then, to consider as an ideal of statistical quality control in manufacture the development of sampling plans combining measurement by variables and by attributes for continuous production so as to attain economically that degree of continuing process control and that degree of elimination of defectives which assures a consistent specified outgoing level of fraction defective.

The permanent place of statistical quality control in the activities of the various interested professional societies has been definitely evidenced by the space which they have accorded to this field in their periodicals. These societies have also devoted sizeble parts of their programs to quality control and it is now regular practice to hold joint sessions of the statistical and engineering societies with the American Society for Quality Control. The size and strength of this society, however, represents the principal evidence of the permanence and maturity of statistical quality control as a professional endeavor. Through its publications, section and national meetings, Mid-West Conferences, clinic sessions, as well as through its education, employment and other committee activities the Society provides a variety of media for the expression of common professional interest of its large membership which is drawn from a wide variety of fields of application.

The continuing development of any intellectual discipline, however, cannot be guaranteed without the education and training of a steady stream of persons prepared to carry on and extend its traditions. The two principal avenues of training started during the war have crystalized into permanent activities carried on by colleges in various parts of the country. These programs, namely the extension courses usually running for a semester and the intensive eight day courses, are planned primarily for indoctrinating operating personnel who may not yet have formally studied quality control. Most of these courses are conducted at a level not requiring prior training in statistics nor making appeal to the use of other than elementary mathematics. Some courses in these two categories, however, are more advanced and require more mathematical background and the equivalent of a first course in statistics. The Rochester Institute of Technology, in particular, has been conducting similar intensive courses for industrial personnel with primary interest in chemistry. These programs are making the practice of statistical quality control available to a rapidly growing body of practitioners whose work calls for it.

Two variants of the intensive type of training have been initiated since the war. In the fall of 1946 the Newark College of Engineering held a training conference on Acceptance Sampling conducted on twelve successive Friday afternoons and evenings. A reasonably advanced and comprehensive coverage of attributes sampling was made possible by the cooperation of a distinguished sponsoring committee and group of lecturers. In September of 1948 at the School of Engineering of Columbia University the Departments of Mathematical Statistics and Industrial Engineering joined in conducting a five day training conference on Industrial Experimentation. The subject matter was somewhat more advanced statistically than that usually covered in the eight day courses, dealing largely with analysis of variance, and stressing the two fundamental models.[24] The appeal of this conference to research men may be indicative of the influence that the industrial practice of quality control is exerting in promoting the practice of statistical scientific method.

In many industrial plants a considerable part the quality control program is taken up with the training of operators and inspectors in the elements of statistical quality control. The precedent set during the war by the E.S.M.W.T. program is being continued on a large scale. In many cases it has been found very effective to coordinate this type of in-plant training with the introduction of a statistical quality control system, and the primary work of many consultants consists of in-plant training. But the factory school is not limited to its own personnel. A number of companies have established a regular practice of bringing groups of their customer's representatives to one of their factories for a short conference. For a long time now the Hunter Spring Company has conducted a number of such two-days sessions each year and more recently the Federal Products Corporation has held occasional one week sessions. The Ford Motor Company now conducts one and one-half day sessions for its vendors. Industrial Organizations themselves have recognized the essential economic value of training and education and are actively engaged in spreading an understanding of statistical quality control not

only to their own staffs, but also by representatives of their customers and vendors, and in some cases to their competitors.

The training of persons already engaged in industrial quality control is undoubtedly an important aspect of its development. The enduring place, however, of a scientific discipline in a nation's culture is reflected by this discipline's place in the more formal channels of education. Today, in this country, college training is essentially within the reach of the whole populace and is the customary channel of professional preparation. Before the war there was almost no recognition of either statistics or statistical quality control in the engineering curriculum. Only in isolated cases were there available single courses in statistical quality control, developed by pioneers in the field. During the war years, largely as the result of Shewhart's far-sighted planning which helped bring into being the E.S.M.W.T. and O.P.R.D. training programs, many more teachers became interested in establishing such courses within the regular programs of their schools. The first full scale formal program, however, was established in 1945 at the University of North Carolina within the structure of its Institute of Statistics. There a Section of Industrial Statistics was set up under the direction of Professor Paul Peach, offering not only a full scale teaching program but also research service to industries of the State of North Carolina. Since 1945 many schools have expanded their offerings and many other schools have initiated one or more courses in statistical quality control.

The extent of the college program need not be detailed here. The American Society for Quality Control in 1949 conductetd a survey among engineering schools, whose findings appeared in the January, 1950 issue of *Industrial Quality Control,* under the title, "Statistics and Quality Control in Engineering Courses." The marked growth of interest in statistics and quality control is clearly indicated by the fact that of the 105 engineering colleges reporting, 49 offered undergraduate courses. In 1949, 2,180 of their students were enrolled in undergraduate statistics in contrast with 450 in 1946, and 2,050 were taking undergraduate quality control courses in 1949 while only 450 did so in 1946. As the article cautions, the results of the survey do not necessarily give an accurate account, since 57 colleges did not reply. Nevertheless the fact is clear that statistics and statistical quality control are so well established as part of the engineering curriculum that it is only a matter of time when these subjects will be, in varying degrees, required of all engineering students.

As this survey shows, courses in quality control are also taught in statistics and mathematics departments to a considerable extent, and to a lesser degree in schools of business. Furthermore, interest in quality control has stimulated a growing interest in theoretical statistics among the engineering schools, many of which are offering statistics courses within degree granting engineering departments. While in most engineering schools these courses are yet optional, they are required in almost all Industrial and Administrative Engineering programs. In many graduate engineering programs qualification in statistics is required although specific course credit is not.

One need not labor further the fact that "statistical method from the view point of quality control" is a recognized part of engineering curricula. The time cannot be far off when the methodologies of theoretical statistics and of statistical quality control take their place beside the formalism of mathematics as an accepted and required part of engineering and science education. This development is being accelerated by the availability, in addition to the books and monographs mentioned above, of a number of college texts, among them, *Industrial Statistics and Quality Control,* by Paul Peach (Edwards and Broughton Co., Raleigh, 1945); *Statistical Quality Control,* by Eugene L. Grant (McGraw-Hill, 1946); *Quality Control in Industry* by John G. Rutherford, Pitman (1948). A number of other college texts on statistical quality control are in various stages of preparation and this activity in text writing is the typical sign of healthy activity in a college subject.

In the span of twenty-five years Statistical Quality Control has developed from its origination by Shewhart as a philosophical conception of scientific method in answer to a specific industrial problem into a working discipline which is an integral part of our culture. The development of this discipline has been unique in that so much of this development is the result of the work of the originator, who apart from formulating the philosophy of the discipline and contributing so many of its techniques, stimulated the active interest of his associates and of the various groups which on a nation-wide scale joined in bringing Statistical Quality Control to its present state of maturity. The stages by way of which scientific ideas usually develop are research, practical implementation and exposition. And when exposition is at the point where scientific ideas are so generally accepted by scholars of science that these ideas are made part of the fundamental education of the young scientist, the discipline comprised of these ideas has attained a lasting place in the culture of the times. The status accorded to statistical quality control and related statistical techniques in our college programs places these disciplines in the permanent body of modern science. The present importance of Statistical Quality Control and of the original conceptions of Shewhart is that of a major contribution to human progress in the sense suggested by E. A. Singer: "The measure of man's cooperation with man in the conquest of nature measures progress."[25]

[22] H. F. Dodge, *Annals of Mathematical Statistics,* September, 1943.

[23] A. Wald and J. Wolfowitz, *Annals of Mathematical Statistics,* March, 1945. Another plan has been presented by F. J. Anscombe in the paper: "Linear Sequential Rectifying Inspection for Controlling Fraction Defective," *Sup. Jour. Royal Stat. Soc.* (8) 2, 1946.

[24] Mr. Bechhofer prepared a set of models which are applicable to some of the more common Analysis of Variance tests. The precise mathematical assumptions and the appropriate forms of statistical analysis were explicitly stated for each model. These notes served as an excellent teaching aid.

[25] Singer, E. A., "On Progress" in *The Contented Life,* Holt (1936).

Abraham Wald

Professor Abraham Wald of Columbia University, a distinguished contributor to statistical theory, and Mrs. Wald were killed December 13, 1950 in south India when an airplane in which they were riding struck a mountain in the Nilgiri range during a storm. The Indian Statistical Institute has several times during the past twelve years invited foreign statisticians to visit India, to lecture and to advise officials, and it was in this capacity that Professor Wald was in India. He had on his way there lectured at London, Paris and Rome.

Abraham Wald was born in 1902 at Cluj, which is better known in this country as Clausenburg or Klausenburg, in Transylvania. This region was at various times while he lived in it under the sovereignty of Russia, Hungary and Rumania. His father, an orthodox Jewish baker, would not permit him to attend school on Saturday, and the local schools would not allow him to attend unless he came Saturdays. Consequently he did not go to school; but by private study he was able to pass the entrance examinations of the local university. After receiving his first degree there he went to Vienna for graduate work in mathematics and received a Ph.D. degree in 1931, working initially in differential geometry. At Vienna Wald was drawn into economics and statistics by Oskar Morgenstern and worked at the Institute for Business Cycle Research there. In the spring of 1938 Alfred Cowles brought him to Colorado Springs, and few months later generously released him to accept a research assistantship in mathematical statistics at Columbia provided by the Carnegie Corporation in a small-scale program that had just produced Madow, Girshick and Doob as mathematical statisticians. Here he became acquainted with the new Anglo-American-Indian mathematical statistics and soon excelled in this field, whose further advancement constituted the remainder of his life work. He did, however, complete at Columbia his earlier ingenious work on the cost-of-living index, work which should be of first-rate importance in connection with an index which has lately come to carry the heavy responsibility for far-flung periodic wage adjustments.

Dr. Wald taught the mathematical statistics and mathematical economics courses at Columbia for a part of the academic year 1939-40 during my absence, and in 1942 was appointed assistant professor of economics, still with the support of the Carnegie Corporation. In 1944 he became an associate professor, and in 1945 was appointed professor of mathematical statistics, though still in the economics department. In 1946 he became chairman of the new department of mathematical statistics. He was vice-president of the Institute of Mathematical Statistics in 1943 and its president in 1948. In 1948 he was also vice-president of the American Statistical Association.

Wald worked with prodigious energy and endurance, and produced a large number of research memoirs on a considerable variety of subjects in mathematical statistics in addition to his earlier work in economics and in differential geometry. His attention began about 1940 to focus chiefly on the general theory of estimation and testing hypotheses; this was an example of his unusual capacity for generalization, whereby he passed quickly from special cases to general principles.

In 1943 the problem of formalizing sequential analysis and experimentation was brought to the attention of the Statistical Research Group that had been organized at Columbia for research in problems referred to it by the army and navy. Sequential experimentation, in which the decision whether to reach a conclusion or to go on experimenting depends at any stage on the results observed up to that point, had always been carried on informally but, apart from the work of Dodge, Romig and Bartky on multiple sampling, without knowledge of exact probabilities or optimum procedures, which had now to be determined. Wald was asked to look into this question, and soon hit on an ingenious approach which he then developed with his characteristic energy. The results were applied immediately, with the help of numerical tables and other auxiliaries produced by the Statistical Research Group, to sampling inspection for quality control of purchases, and by the end of the war were in use in some five thousand factories producing military supplies. Other military applications were also planned. This development seemed important enough to justify some attempt to keep it out of the hands of the enemy, and sequential analysis was classified as "Restricted." At this point a rather ludicrous difficulty arose because of the requirement that enemy aliens should never be allowed to see "Restricted" matter, while in view of the ambiguous nationality of his birthplace Wald was officially regarded as an enemy alien. This impasse led to a facetious suggestion that each page he wrote should immediately be snatched away and never shown to him again, but was resolved when a federal court granted him a hearing long before his turn on the docket and promptly naturalized him. Declassification and publication came before the war's end, and Wald's work in sequential analysis immediately became a classic. The concept is so fundamental that in future treatises on statistics it will very possibly receive serious treatment, not as an afterthought in a final chapter or appendix, but near the beginning of the book as a basis for the development of the older statistical methods as special cases.

A generalization which may appear even earlier in future textbooks is Wald's subsequent theory of decision functions. This deals with the very broad prob-

lem of selecting one out of a plurality of possible actions on the basis of observations made or to be made. The possible actions may be finite or infinite in number (as in selecting a particular value for an unknown quantity), and the number of observations may be predetermined or may be indefinite and sequentially determined. The need of extending the dichotomy of accepting or rejecting a hypothesis to multiple choices, and the notion of a risk function, had come to Wald's mind by 1939 when he introduced a minimax principle resembling that used in the theory of games. These were all combined in the grand generalization he reached in 1947, and which appears with extensions in his recent book *Statistical Decision Functions.* His work in the field was not complete; he had laid out for himself a program of research in it which he estimated would require five years. The magnitude of the concept is such as not merely to add a new chapter to inductive logic but to revolutionize its basis.

Dr. Wald's extensive work will be reviewed in greater detail by J. Wolfowitz, his closest associate in much of the past decade, in an article which with a photograph is expected to appear at the beginning of the 1952 volume of the *Annals of Mathematical Statistics.* It is planned to dedicate this volume to Dr. Wald's memory, and to include, especially in the first issue, as much as possible of the new research based on that of Wald.

As a gentle and kindly friend and collaborator Abraham Wald was unsurpassed. In 1941 he married Lucille Lang. They had two children, Betty, seven years old, and Robert, three, who remain with Mrs. Wald's sister. Dr. Wald was affected by the tragic disappearance during the war of his parents and other relatives in his native city, who were later traced to the Nazi extermination camp at Oswieczim, with only one brother, now in New York, surviving.

HAROLD HOTELLING

RESOLUTION IN HONOR OF ABRAHAM WALD

Adopted by The American Statistical Association and the Institute of Mathematical Statistics at membership meetings in Chicago, Illinois, December 27 and 28, 1950

The following resolution was adopted by the American Statistical Association and the Institute of Mathematical Statistics at their meetings in Chicago December 27 and 28, 1950:

Whereas the death of Professor Abraham Wald, who with Mrs. Wald was killed in an airplane crash in India, deprives statistics of a vigorous, brilliant, and original contributor to its fundamental ideas; and

Whereas the future of statistical methods will be vitally affected by Abraham Wald's introduction of a formalized and accurate method of sequential analysis, and by his work on the foundations of statistical inference, including particularly the consideration of loss and risk functions, of general decision problems, of the minimax principle and the related theory of games, of the nature of the estimation of unknown quantities, and of the testing of hypotheses; and

Whereas the efforts of American industry and the military and naval services of supply were materially aided in the successful conduct of the Second World War by widespread application of Abraham Wald's work, particularly to the quality control of manufactured articles; and

Whereas his contributions to statistical methods and theory were substantial in such varied fields as the foundations of probability, inequalities on distributions in terms of moments, the treatment of time series, long cycles resulting from repeated integration, tolerance limits, analysis of variance, asymptotic large-sample distributions, and the estimation of parameters of stochastic processes; and

Whereas Abraham Wald contributed also to economics and economic statistics by his penetrating studies of equations of production and of general equilibrium, of index numbers of cost of living, and of the determination of indifference loci by means of Engel curves; and

Whereas he made in his earlier career in Europe valuable contributions to pure mathematics in the fields of differential geometry and the axiomatization of metric spaces; and

Whereas he served the American Statistical Association as Vice President and the Institute of Mathematical Statistics as President and as member of its Council and of the Editorial Board of the *Annals of Mathematical Statistics;* and

Whereas great inspiration is to be derived from the example of Abraham Wald in his surmounting of the difficulties caused by the discrimination and restrictions that, in his East European environment, denied him the opportunities of the primary and secondary schools; in his entrance to the university in his native city of Klausenburg by examinations for which he had prepared himself; in his graduation with distinction and his brilliant graduate work at the University of Vienna; in his migration to this country at the time of the fall of Austria; in his fortitude in enduring the loss of his nearest relatives by the Nazi policy of genocide; in his devotion to our science and in his habits of hard work which brought a great volume of substantial contributions; and in his ability to be friendly and kind under the severest strains; now therefore

Be it resolved that the American Statistical Association and the Institute of Mathematical Statistics jointly record their deepest sorrow and regret at the untimely passing away in middle life of a great contributor, and at the further tragedy that his wife also was taken; and that these Associations extend their sincere sympathy to the bereaved relatives and particularly to the two young children who remain.

QUESTIONS and ANSWERS

edited by FREDERICK MOSTELLER
Harvard University

AREA SAMPLING

Question 30. What is the present status of area sampling? What are the advantages and disadvantages of area sampling? What are the complications that arise in area sampling?

Answer. *Definition of area sampling.* Before this question is answered, the term "area sampling" must be defined. It became current during the past decade as a procedure for sampling populations by a random, systematic, or stratified-random selection of areas, usually followed by the drawing of a subsample within each of the selected areas by further application of systematic or random sampling methods. The sampling of areas is more than 50 years old and is well developed in agricultural research, forestry, and elsewhere. Although the term has frequently been used in contradistinction to quota sampling, there are sampling procedures which combine the use of area units with quota and other non-random selection procedures. Hence the distinction between methods that make use of area units and other methods is not as important as certain other distinctions that can be taken as the basis for characterizing sampling methods.

In the remainder of this answer we will be concerned with sampling procedures that utilize the theory of probability as a basis for the selection of unitary areas and possibly for subsampling within them, the whole procedure being applied to sampling human populations in surveys conducted by interviewing persons in their homes. The fundamental purpose of such procedures is to obtain both (a) accurate estimates of several variables for the population and (b) fair approximations to the measurement of the accuracy of the estimates, at least for the components of variation induced by the sampling procedure. As will now be pointed out, this type of procedure is a variety of a larger class of sampling methods commonly designated as "probability sampling."

A probability sampling procedure is one in which a specified probability model is associated with the population and the sampling operation, the correspondence between the model and the actual sampling being close enough to warrant computing from the model and the data, estimates for the population and also sampling error variances for these estimates. Thus, for a finite population, simple random sampling is that method which associates equal probability with each of the possible samples of the desired size. A simple random sample is usually drawn by making use of devices such as shuffled cards and random number tables.

The design of a probability-model procedure frequently involves practical as well as theoretical problems. Thus simple random sampling can seldom be used even though a complete listing of the individual elements in a population is available. An excellent illustration of this is provided by the experience of the English Social Survey, described in a recent paper by Gray and Corlett (1). Although population registers were available to the Social Survey from which to select simple random samples, the cost of sending enumerators to such a sample would be prohibitive. Under such circumstances it is advantageous to carry out sampling in several stages. That is, the population is first separated into a set of mutually exclusive and exhaustive groups of elements; a sample of these groups is selected; and finally, all or a sample of elements from the chosen groups constitute the total sample to be studied. The groups of individual population elements which are to be used as sampling units are frequently referred to as "clusters". In the case of the Social Survey, these clusters were defined on the basis of geographic or administrative considerations. The registers were of course used to select simple random samples from within each cluster drawn into the sample. This clustering decreases the distance and the time required to go from one sample element to another in canvassing the sample.

Probability sampling procedures in the United States have tended in this same direction, but without the help of national registers. Clusters have been defined by associating individuals with the area in which they live, and a sample of these areas is then selected by probability methods. This process is the one which we shall refer to as *area sampling*. Thus area sampling is a special case of cluster sampling which is in turn a special type of probability sampling procedure..

The present status and role of theory. At the present time there exists a very large and growing body of theory which is applicable to cluster sampling and therefore to area sampling. Concretely, this body of theory consists of a series of probability models, each of which is described or analyzed in accordance with the following steps: (1) the manner in which probabilities are to be assigned to the population clusters (or areas) is specified—e.g., each cluster is given an equal probability, or each cluster is given a probability which is proportionate to its size; (2) the number of elements to be chosen from each sample cluster is stated—e.g., a constant number or a constant proportion is to be taken from each cluster; (3) the form of the estimate is given—e.g., an unweighted mean of cluster means or a weighted mean of cluster means; (4) the estimate is classified as biased or unbiased, this classification following from steps (1), (2), and (3); (5) the sampling variance of the estimate is specified in terms of population parameters—e.g., the population variance, and (6) a procedure is given for estimating the sampling variance of the estimate from an actual sample. In addition to these points the theory is beginning to take account of cost factors. Although in the past much of this theory has been available only in the periodical literature, several books have appeared in recent years (2) (3) (4) and more are scheduled to appear.

The above theory can be used in one of two ways. First, if a set of area clusters is assumed, a probability model can be selected which is most suitable for the problem at hand. The theory will then allow one to determine the details of the design—number of clusters to be chosen, number of elements to be taken from each cluster, etc.—so as to conform to the restrictions imposed by cost, administration and accuracy. Actually, of course, the extent to which these restrictions can be realized depends upon how accurately one knows or can guess at the values of certain population parameters. The second use of the theory goes back one step further than the preceding and treats the problem of defining the area clusters, i.e., dividing the population into areas in the most advantageous manner. Here again it is necessary to know or guess at the values of a number of population parameters.

Definition of area sampling units. One of the most important and difficult tasks associated with the design of a large-scale area sample in the United States involves the definition of areas which are to be used as sampling units. Actually, this definition process progresses in stages so that large administrative areas are first chosen, then smaller ones within the larger areas, and so on. For example, the following quotation (5) describes the general procedure used in selecting the sample for the Survey of Consumer Finances: "First, counties are selected; then cities, towns, or townships within counties; then city blocks in cities and small geographical areas in other places; finally dwelling units within the blocks or areas." The last two stages usually call for information over and above that which is readily available. However, the "Master Sample" comprises maps and other materials which greatly facilitate this portion of the definition process. Developed jointly by Iowa State College, the U. S. Bureau of Agricultural Economics and the U. S. Bureau of the Census, the material can now be obtained from the Bureau of the Census. Unfortunately, there is presently no published account of the extent to which the Bureau of the Census can contribute to a particular sample

design nor of the costs which would be involved in using the Master Sample materials. It is to be hoped that this situation can be remedied in the near future.

The field execution of an area sample. Once a sample of small area units has been chosen according to a probability model, field workers are sent to the chosen clusters, either to enumerate the dwelling units in each cluster or to enumerate and select a sample of respondents. Errors can creep into this operation in a number of ways. The boundaries of the sample cluster can be misinterpreted; dwelling units can be omitted from the enumeration; or, errors can be made in carrying out the sampling instructions. It is difficult to predict what the effects of such errors will be, but it is easy to see that they may have some effect. For example, omitted dwelling units will tend to be those lying on unnoticed alleys, those located in the rear of commercial or industrial establishments, etc., and the occupants of such dwelling units will have different characteristics from those people who live in more accessible locations. Few data are available to illustrate the number or the influence of such errors, but a beginning in this direction is provided by Hyman and Mannheimer (6).

While the household or dwelling is the ultimate unit in some surveys such as those of housing, labor force, or consumer behavior, it is not suitable for studies of attitudes and similar individual variables, since the interview with one member of the household may influence the responses of other members that might be interviewed in turn. Hence the final step in sampling may be the selection of one individual in each household. Several methods of doing this on a probability sampling basis have been utilized. One such method is described by Kish (7). It is a bit awkward to choose one member of the household and reject the others during the first few minutes of contact with a household especially if the member so chosen is not immediately available to be interviewed but interviewers are developing skill in handling such situations.

Following the determination of the exact individuals who are to be interviewed, it is next necessary to interview them. This, as past experience well demonstrates, is not a trivial problem. Urban surveys ordinarily find only 30 to 40 per cent of a sample of *individuals* at home on the first call. Even if the interviewer is permitted to obtain the information from any responsible person who is at home in a dwelling unit in his sample, only 60 to 70 per cent of the assigned interviews are completed on the first call. Since those individuals who are relatively difficult to contact differ in many respects from those who are relatively easy to contact (more frequently male, younger, better educated, have fewer children) one must balance the risk of having serious biases enter the sample results if one substitutes an interview with some other person who is at home against the greater cost of obtaining an interview by making callbacks. Some illustrative data on this problem are furnished by Hilgard and Payne (8). Several possible approaches to this problem, other than the obvious one of calling back, are described by Hansen and Hurwitz (9) and by Politz and Simmons (10). The first involves sampling the "not-at-homes" while the second obtains information on "at home" times from those who are interviewed and uses this to adjust the sample results. Recent evidence shows that calling back often does not cost much more than obtaining an equivalent number of interviews from an additional sample of households.

Even after individuals have been contacted for interview, sample losses may still be expected, primarily because of refusals. The loss of people who refuse to be interviewed can also have a marked effect on sample results since refusals are more frequent in some groups such as older females and the foreign-born than others. It would seem at the present time that a reduction in these losses would have to come principally through the medium of interviewer training. Some evidence for this point of view is presented by Heneman and Patterson (11), though the reader should note that their low rates were obtained in surveys that used a short interview and did not require the interviewer to see a specified individual in each household.

Summary. Area sampling provides a means of assigning a "feasible" probability model to a population for which no lists of elements exist or for which a geographic clustering of sample elements is necessary in order to reduce field costs. The main advantage associated with the use of a probability-model design is that one can deduce from the model the characteristics of estimates made from actual samples, *provided that the sample is chosen and executed in accordance with the design.* Advance specifications of these characteristics depend upon having a knowledge of certain population parameters, and with the exception of repetitive surveys, these are seldom known with any degree of accuracy.

At some stage in the design of an area sample, it is often necessary to use area units which are smaller than those which have been defined for administrative purposes. The definition of such units may be a costly operation if it must be done for each individual sample. Centrally produced maps and lists, such as the materials of the "Master Sample" that are available from the U. S. Bureau of the Census (12), should be helpful in this connection. However, at present there is no published information on the cost or extent of such services.

The execution of an area sample ultimately depends, as does any other type of sample, on the performance of human agents. Deviations from design will mean that deductions made from the probability model will be approximations whose accuracy can be judged only by careful examination of all the major phases of the survey operation.

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CHAPTER NOTES

BOSTON

The January meeting of the Chapter heard Dr. Joseph Healy, Director of the Massachusetts Special Commission on Taxation, speak on "The Relative Burden of Taxation on Industry in Massachusetts." The Chapter reports that the Boston Statistical Club, started last spring under the sponsorship of the Boston Chapter for college students in the Boston area, now has over 100 members and is planning a full program for the current year.

CENTRAL NEW JERSEY

The December meeting was on the subject of "Recent Developments in Latent Structure Analysis." Paul F. Lazarsfeld, Chairman of the Department of Sociology at the Graduate School of Columbia and Associate Director of the Bureau of Applied Social Research in New York City was the speaker.

J. Stevens Stock, Past President of the New Jersey Chapter, who is now with the Bureau of Labor Statistics as a Consultant on its Consumer Price Index, spoke at the January meeting on "Statisticating Consumer Price Indexes."

CENTRAL INDIANA

In November Purdue University was host to members of the Central Indiana Chapter of the American Statistical Association. The University presented two speakers, Raymond J. Fessen who discussed "Some Practical Aspects of Survey Design" in the afternoon and R. L. Anderson whose topic for the evening was "The Use of Regression Techniques with Economic Data." The Chapter held its December dinner meeting in Indianapolis. E. J. Fisher, research director for the Indianapolis Star-News, was the speaker. His topic for the evening was "Political Polls." He discussed some of the sampling techniques used by midwest newspapers to forecast election returns. An interesting and lively discussion followed Mr. Fisher's presentation.

CONNECTICUT

The Annual Dinner Meeting of the chapter which was held last December heard an address by Chester I. Bliss of the Connecticut Agricultural Experiment Station and Yale University, who spoke on "Sequential Procedure for Grading Milk by Microscopic Counts."

The following officers were elected for 1951: President, William Haensel, Bureau of Vital Statistics, Hartford; Vice-President, Geoffrey Beall, University of Connecticut; Secretary-Treasurer, D. F. Votaw, Jr., Yale University; Executive Committee, H. E. Arnold, Wesleyan University, and F. L. Strodtbeck, Department of Sociology, Yale University.

DENVER

The December meeting dealt with "The Place of Statistics in Our Defense Program." Lt. Col. Joseph A. Hreha and Maj. Alfred L. Moller both of Lowery Air Force Base in Denver were the speakers. The January meeting was devoted to a discussion of the Annual Meeting of the American Statistical Association which was held in Chicago during Christmas week. Reporters were Edward C. Bryant, Maurice Davies and Henry B. Moore.

The February meeting heard Floyd K. Harmeton of the College of Commerce, University of Wyoming, speak on "Coordination of State Statistics."

HAWAII

The following officers of the Hawaii Chapter were elected for the year 1951: President, Carl A. Farden; First Vice-President, L. P. Carter; Second Vice-President, Richard S. Takasaki, and Secretary-Treasurer, Lillian S. L. Louis.

NEW YORK

The Committee on Census Enumeration Areas is one of the most active groups in the New York Chapter. At their meeting on December 12. Mr. Lawrence of the Washington Census Bureau described the methods used in rechecking and reported the addition of something over 10,000 persons to the population count. Dr. Shryock described to the Committee the plans for tabulations on population and housing by census tracts as well as for larger areas. Because of intense local interest in small area data, the Census Bureau will publish the standard tract tables for 1950 by census tracts, almost 2,500.

The Census Committee also approved a set of districts for the tabulations of 1948 retail trade data to be purchased by a group of organizations. A special subcommittee is currently exploring the problem of small area data on wholesale and service trades and on manufacturing. Neva R. Deardorff is Chairman of this committee and Florence E. Cuttrell is Secretary.

Nathan Morrison, Secretary of the Statistical Techniques Division, reported that the meeting on December 20 was addressed by H. L. Seal, of Wickenden, Morss and Associates, Inc., on the subject of "Recent Developments in Actuarial Techniques." The affair was held at the Johnny Victor Theatre in the R. C. A. Exhibition Hall.

The Senior District Representatives, Charles M. Armstrong and Lester R. Frankel, are planning to hold a regional meeting late in the spring and met with the New York Chapter on January 24 to formulate plans.

OKLAHOMA CITY

At the annual dinner meeting of the Chapter held in January, the following officers were elected for 1951: President, R. S. McCauley; Vice-President, Walter B. Jessee; Vice-President, W. [illegible] Hill, and Secretary-Treasurer, Ross [illegible]lan.

PHILADELPHIA

The December meeting of the Chapter was the second session devoted to the Mobilization Program of the United States. The speaker was Karl R. Bopp, Vice-President in charge of Research of the Federal Reserve Bank of Philadelphia. He spoke on "Financial Mobilization for Defense."

The January meeting of the Chapter heard a panel of three Philadelphia industrialists present their views concerning the impact on the economy of direct controls on prices, materials and wages. The panel consisted of Benedict Saurino, Manager of the Statistical Research Division of Sun Oil Company, as moderator; Alfred Egandorf, Merchandise Manager of Lit Brothers; and James H. Robins, President of American Pulley Company.

ST. LOUIS

The St. Louis Chapter took the initiative in calling a meeting of persons in various State Departments responsible for compiling statistical reports together with several other statisticians interested in the use of statistics compiled by state agencies. There was a discussion of the methods used by the Metropolitan St. Louis Census Committee and of various possible series of data which might be used in estimating population. As a result of the discussion Clyde Bridger, of the Bureau of Vital Statistics, was asked to develop estimates of the population of the counties in the State of Missouri and a committee under the chairmanship of Charles Hawkins was appointed to assist Mr. Bridger.

The December meeting of the Chapter dealt with Price Forecasting. Durfee L. Combs, Economist at Longstreet-Abbott and Company and Lecturer in Statistics at Washington University, discussed his experience in analyzing and forecasting the price of cotton. The discussion covered the strategic factors to be considered by price forecasters, the time period for which a price forecast might be valid, and the assumptions underlying any price forecast which must be thoroughly understood in order to appraise the limitations and reliability of the forecast.

WASHINGTON STATISTICAL SOCIETY

The January meeting dealt with some of the statistical problems involved and the techniques used in weather forecasting. Herbert Thom, Climatological and Hydrologic Services Division, U. S. Weather Bureau, spoke on "The Application of Climatological Methods"; Nicholas Manos and William Soreen, Air Weather Service, Military Climate Division, USAF, gave a joint paper on "Probabilities from Limited Weather Data"; Glenn Brier, Scientific Services Division, U. S. Weather Bureau, spoke on "Experimental Design in Meteorology"; and Robert Allen, Scientific Services Division, U. S. Weather Bureau, spoke on "Some Statistical Problems in Short Range Weather Forecasting."